17a

Sexually Transmitted Diseases and AIDS

Lecture Presentation

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Sexually Transmitted Diseases and AIDS

OUTLINE:

- Long-Lasting Effects of STDs and STIs
- STDs Caused by Bacteria
- STDs Caused by Viruses
- HIV/AIDS
Long-Lasting Effects of STDs and STIs

- 19 million infections occur each year in the United States
  - Two-thirds of the U.S. residents infected are younger than 25

- Sexually transmitted diseases (STDs)
  - Transmitted by sexual contact
  - Caused by bacteria or viruses
  - Most common among adolescents and young adults
Long-Lasting Effects of STDs and STIs

- STDs have more severe health consequences for women than for men
  - Sterility
  - Ectopic pregnancy
  - Cervical cancer
Long-Lasting Effects of STDs and STIs

- Challenges
  - Many people are unaware they are infected
    - Often no symptoms
    - Prompted use of the term “sexually transmitted infection” rather than “disease”
  - Symptoms may disappear without treatment, leading a person to mistakenly believe that he or she is cured
Long-Lasting Effects of STDs and STIs

- Chlamydia, gonorrhea, and syphilis
  - Caused by bacteria
  - Can be cured with antibiotics
Figure 17a.1 The relative rates of chlamydia, gonorrhea, and syphilis from 1984 to 2010.
Chlamydia

- Most frequently reported infectious disease in the United States
  - Highly contagious
  - Caused by the bacterium *Chlamydia trachomatis*
    - Cannot grow outside a human cell
    - Infects mucous membranes
Chlamydia

- Symptoms of chlamydia
  - In men: inflammation of the urethra causes burning sensation upon urination
  - In women: pelvic inflammatory disease may cause pain in abdomen or lower back, abnormal vaginal discharge or bleeding, and pain during intercourse
  - May cause no noticeable symptoms
Chlamydia

- Long-term consequences of untreated chlamydial infection
  - In men
    - Sterility can result if infection scars the vas deferens
  - In women
    - Sterility can result if infection scars the oviducts
    - If the oviduct is only partially blocked and fertilization occurs, then an ectopic pregnancy may result
Chlamydia

- Chlamydial infection and pregnancy
  - Can cause the protective membranes around the fetus to rupture, killing the fetus
  - Can be transferred to a fetus at birth

- Chlamydiial infection
  - Diagnosis
    - Urine test detects the DNA of *Chlamydia trachomatis*
  - Treatment
    - Antibiotics
Gonorrhea

- Caused by the bacterium *Neisseria gonorrhoeae*
- Infects mucous membranes
- Generally transferred when an infected mucous membrane directly contacts another mucous membrane
Gonorrhea

- Symptoms of gonorrhea
  - Similar to those of chlamydia
  - In men: inflammation of the urethra causes burning sensation during urination
    - May include discharge from the urethra
  - In women: pelvic inflammatory disease
Figure 17a.2 A yellowish white discharge from the urethra caused by gonorrhea.
Gonorrhea

- Long-term consequences of untreated gonorrhea
  - In men
    - Sterility can result if infection scars the vas deferens
  - In women
    - Sterility can result if infection scars the oviducts
    - If the oviduct is only partially blocked and fertilization occurs, then an ectopic pregnancy may result
Figure 17a.3 *Chlamydia and gonorrhea can cause pelvic inflammatory disease.*

Complete blockage of one oviduct by scar tissue causes infertility. Complete blockage of both oviducts causes sterility.

Partial blockage of an oviduct reduces fertility and increases the risk of an ectopic pregnancy.

The egg may be too large to move past the blockage, but sperm may be small enough to swim past the blockage and fertilize the egg. The embryo may then implant in the oviduct, causing an ectopic pregnancy.
Gonorrhea

- Diagnosis
  - Urine test to detect DNA of *Neisseria gonorrhoeae*
  - Examine smear of cells taken from infected area

- Treatment
  - In the past, easily cured with antibiotics
  - Now, some strains of the bacterium are drug resistant
Syphilis

- Caused by the bacterium *Treponema pallidum*

- Routes of entry
  - Can invade any mucous membrane
  - Can enter through a break in the skin
  - Can cross the placenta and infect a growing fetus
Syphilis

If untreated, syphilis progresses through three stages

1. Chancre
2. Rash
3. Gummas
Syphilis

- First stage of syphilis
  - Chancre forms at site of contact
    - Normally appears within two to eight weeks of the initial contact
  - Diagnosis
    - Identify bacterium in discharge from a chancre
  - Treatment
    - Antibiotics
Syphilis

- Second stage of syphilis
  - Characterized by a rash
    - Covers entire body, including palms of hands and soles of feet
    - Usually appears a few weeks to a few months after disappearance of chancre
  - Most contagious stage
- Diagnosis
  - Blood test to detect antibodies for *Treponema*
- Treatment
  - Antibiotics
Syphilis

- Third stage of syphilis
  - Lesions (gummas) appear on the skin or internal organs, including the aorta
  - Infection can spread to the nervous system, causing paralysis, insanity, or blindness

- Treatment
  - Very difficult at this stage
  - Requires massive doses of antibiotics over a prolonged period of time
Figure 17a.4 Untreated syphilis goes through three stages.

**Step 1:** The first stage of syphilis is characterized by a chancre, a hard, painless, crater-shaped bump at the place in the body where the bacteria entered, usually the genitals.

**Step 2:** A reddish-brown rash covers the entire body, including the palms of the hands and the soles of the feet.

**Step 3:** Lesions, called gummas, shown here on the hand, are characteristic of the third stage of syphilis. These lesions can also form on the blood vessels, the central nervous system, and the bones.
# Table 17a.1 Overview of Bacterial STDs

<table>
<thead>
<tr>
<th>Disease</th>
<th>Symptoms</th>
<th>Diagnosis and Treatment</th>
<th>Effects</th>
</tr>
</thead>
</table>
| Chlamydia | First symptoms occur 7–21 days after contact  
Up to 75% of women and 50% of men show no symptoms  
Women:  
Vaginal discharge  
Vaginal bleeding between periods  
Pain during urination and intercourse  
Abdominal pain accompanied by fever and nausea  
Men:  
Urethral discharge  
Pain during urination | Diagnosis:  
Urine test for chlamydial DNA  
Treatment:  
Antibiotics | Long-term reproductive consequences, such as sterility  
Infection can pass to infant during childbirth  
Can cause rupture of the protective membrane surrounding the fetus |
| Gonorrhea | First symptoms occur 2–21 days after contact  
About 30%–40% of men and women show no symptoms  
Women:  
Vaginal discharge  
Pain during urination and bowel movement  
Cramps and pain in lower abdomen  
More pain than usual during menstruation  
Men:  
Thick yellow or white discharge from penis  
Inflammation of the urethra  
Pain during urination and bowel movements | Diagnosis:  
Examination of penile discharge or cervical secretions  
Urine test for DNA of the bacterium that causes gonorrhea  
Cell culture  
Treatment:  
Antibiotics | Can cause long-term reproductive consequences, such as sterility  
Infection can pass to infant during childbirth  
Can cause heart trouble, arthritis, and blindness |
| Syphilis  | Stage 1:  
Occurs 2–8 weeks after contact  
Chancr forms at site of contact  
Lymph nodes in groin area swell  
Stage 2:  
Occurs 6 weeks to 6 months after contact  
Reddish brown rash appears anywhere on the body  
Flu-like symptoms present  
Ulcers or warty growths may appear  
Patches of hair may be lost  
Stage 3:  
Lesions appear on skin and internal organs  
May affect nervous system  
Blindness  
Brain damage | Diagnosis:  
Identification of the bacterium from a chancr  
Blood test to detect antibodies to the bacterium that causes syphilis  
Treatment:  
Large doses of antibiotics over a prolonged period of time | Infection can pass to fetus during pregnancy  
Can cause heart disease, brain damage, blindness, and death |
STDs Caused by Viruses

- The symptoms caused by viral STDs can be treated, but they cannot be cured

- Always important to take precautions not to pass these viruses to others
Genital Herpes

- Caused by herpes simplex viruses (HSVs)
  - HSV-1 (more common above the waist)
  - HSV-2 (more common below the waist)
- Can enter the body at mucous membranes or breaks in the skin
Genital Herpes

- Symptoms of herpes
  - Fever, aching muscles, swollen glands in the groin
  - Blisters appear and may ulcerate, leaving sores (most contagious at this time)
  - Virus retreats to ganglia near the spinal cord and is reactivated during times of stress
- Symptoms may not be present
Figure 17a.5 *Herpes simplex viruses.*

**a)** Genital herpes, shown here on the external genitalia of a female, is usually caused by HSV-2.

**b)** Genital herpes, shown here on the penis, is usually caused by HSV-2.
Genital Herpes

- Herpes infection
  - Can sometimes spread to a growing fetus and cause miscarriage or stillbirth
  - Can be transmitted to the fetus during delivery
    - Delivery by Cesarean section avoids exposure of the baby to the virus
- Diagnosis
  - Examine sores
  - Test fluid from sores for presence of virus
  - Identify DNA of the virus from swab of infected area
  - Blood tests for antibodies to the virus
Genital Herpes

- **Treatment**
  - **Antiviral drugs**
    - Ease symptoms
    - Can reduce frequency of recurrence
    - Strains resistant to antiviral drugs are appearing
HPV and Genital Warts

- Caused by several Human papillomaviruses (HPVs)
- Most common of viral STDs in United States
- Body’s defense mechanisms usually eliminate HPV without the virus causing serious health problems
- However, certain strains of HPV persist for long periods and can lead to cervical, penile, or anal cancer
HPV and Genital Warts

- Diagnosis of genital warts
  - Appearance of genital warts
  - In women, also by the appearance of precancerous cells in a Pap test
Figure 17a.6 Genital warts on the penis.
HPV and Genital Warts

- Treatments for genital warts
  - Intended to kill the cells that contain the virus
  - Include freezing, burning, laser, surgery, and chemical treatment

- New vaccine for females
  - Effective against four HPVs
    - Including two strains that are responsible for most cases of cervical cancer
  - Recommended age at vaccination: 10 to 12 years old
HPV and Genital Warts
Table 17a.2 Overview of Viral STDs

<table>
<thead>
<tr>
<th>Disease</th>
<th>Symptoms</th>
<th>Diagnosis and Treatment</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genital herpes</td>
<td>First symptoms appear 2–20 days after contact</td>
<td>Diagnosis: Examination of blisters</td>
<td>Cannot be cured</td>
</tr>
<tr>
<td></td>
<td>Many people have no symptoms</td>
<td>Laboratory test on the fluid from the sore to detect the presence of the virus</td>
<td>Recurrences of blisters</td>
</tr>
<tr>
<td></td>
<td>Flu-like symptoms present</td>
<td>Blood test for antibodies</td>
<td>Infection can pass to fetus, causing miscarriage or stillbirth</td>
</tr>
<tr>
<td></td>
<td>Small, painful blisters that can leave painful ulcers appear</td>
<td>Treatment: Antiviral drugs can ease symptoms</td>
<td>Can cause brain damage in newborns</td>
</tr>
<tr>
<td></td>
<td>Blisters go away, but the virus remains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Symptoms recur periodically</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPV genital infection</td>
<td>First symptoms appear 1–6 months after exposure; presence of symptoms depends on type of HPV</td>
<td>Diagnosis: Appearance of growth</td>
<td>Formation of additional warts</td>
</tr>
<tr>
<td></td>
<td>Small warts appear on sex organs</td>
<td>In women, Pap test may help</td>
<td>Closely associated with cervical cancer and penile cancer</td>
</tr>
<tr>
<td></td>
<td>May cause itching, burning, irritation, discharge, bleeding</td>
<td>Treatment: For removal: freezing, burning, laser surgery</td>
<td>Infection can pass to infant during childbirth</td>
</tr>
</tbody>
</table>
HIV/AIDS

- Acquired immune deficiency syndrome (AIDS)
  - Acquired (not inherited like many other immune deficiencies)
  - Syndrome (set of symptoms caused by the human immunodeficiency virus, HIV)
- Primary targets of HIV are helper T cells, which serve as the main switch for the immune response
  - Infection and eventual death of helper T cells cripple immune system
    - Opportunistic infections occur and eventually cause death
Global Pandemic

- HIV infection is a global pandemic
  - At the end of 2010, 34 million people were living with an HIV infection
  - Africa is currently the area hardest hit by HIV
    - Two-thirds of the people living with HIV are in sub-Saharan Africa
Form of HIV

- Genetic material is RNA
- Several virus-specified enzymes
- Protein coat surrounds RNA and enzymes
- Envelope surrounds protein coat
  - Consists of protein units embedded in a lipid membrane
  - Lipid membrane is a piece of plasma membrane from previous host cell

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**Figure 17a.7 The structure of HIV.**

- **HIV’s genetic information is in the form of RNA.**
- **Reverse transcriptase** is the enzyme that rewrites HIV’s RNA as DNA.
- **Viral proteins surrounding the core**
- **Core proteins**
- **The envelope** comes from the cell membrane of the previous host cell.
- **HIV’s protein spikes are embedded in the envelope of HIV.**
- **The tip of HIV’s protein spike fits into receptors on the host cell, allowing HIV to enter the cell.**
Replication of HIV

- HIV binds to an uninfected cell
  - Protein spike of HIV fits into CD4 receptor on host cell
  - Helper T cells are the target with CD4 receptors
- Contents of HIV enter host cell
- Inside the host cell, reverse transcriptase rewrites HIV’s RNA as double-stranded DNA
Replication of HIV

- Newly formed viral DNA spliced into host DNA
- The viral DNA is copied along with the host DNA
- Eventually the cell becomes a virus factory
- Viral components bud off from host cell and self-assemble into new viruses
Figure 17a.8 The life cycle of HIV.

Step 1: HIV attaches to a CD4 receptor on the cell membrane of the host cell.

Step 2: HIV fuses with the cell membrane and releases its contents into the host cell.

Step 3: HIV’s protein coat degrades. HIV’s RNA and reverse transcriptase are released into cell cytoplasm.

Step 4: Reverse transcriptase rewrites HIV’s single-stranded RNA as HIV’s double-stranded DNA.

Step 5: HIV’s DNA enters the host cell’s nucleus and is then inserted into the DNA of a host cell chromosome.

Step 6: Many copies of single-stranded HIV RNA are made. They direct the synthesis of HIV’s proteins.

Step 7: HIV RNA and proteins gather at the cell membrane and leave the host cell as an immature virus.

Step 8: HIV RNA and proteins are reassembled to form a mature virus.
HIV: The AIDS Virus

To replicate, a virus must infect a host cell. After entering a cell, the virus uses the cell's molecular machinery to make more copies of itself. It then transmits these copies to new host cells or to another host individual. This tutorial illustrates the life cycle of the human immunodeficiency virus (HIV)—the virus responsible for AIDS.

Press "PLAY" to begin Animation.
Transmission of HIV

- Found in many bodily fluids
- Only transmitted by blood, semen, vaginal secretions, and breast milk
- HIV cannot be transmitted through casual contact
Transmission of HIV

- Major modes of HIV transmission
  - Unprotected sexual activity
  - Intravenous drug use: contact with infected blood
  - From an infected mother to her offspring
    - Across the placenta
    - During delivery
    - In breast milk
Sites of HIV Infection

- Infect any cell that has a CD4 receptor
- Mostly the helper T cell, which turns on the entire immune response
- Decline in helper T cell numbers, leaves the body increasingly defenseless against other infections
Sites of HIV Infection

- Can also infect the brain, killing nerve cells
  - Symptoms can include forgetfulness, impaired speech, inability to concentrate, depression, seizures, and personality changes
- Roughly 60% of people with AIDS have signs of dementia
Stages of HIV Infection

1. Initial infection
2. Asymptomatic stage
3. Initial disease symptoms
4. Early immune failure
5. AIDS
Figure 17a.9 Stages of HIV infection.

- Initial infection
- Asymptomatic stage
- Initial disease symptoms
- Early immune failure
- AIDS

Graph showing:
- T-Cell Count in Blood (cells/mm³)
- CD4 T lymphocytes
- HIV
- Years since infection
- HIV per ml Plasma

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Stages of HIV Infection

- Initial infection
  - Virus replicates
  - Body’s immune system produces antibodies against the virus
    - HIV test looks for antibodies to HIV in the blood
    - If antibodies found, the person is described as “HIV positive”
  - No symptoms or mild symptoms
Stages of HIV Infection

- Asymptomatic stage
  - Immune system mounts strong defense
    - Infection is controlled, but not conquered
  - Virus is in the lymph nodes, infecting millions of cells
Stages of HIV Infection

- Initial disease symptoms
  - Wasting syndrome (unexplained weight loss)
  - Swelling of lymph nodes
  - Neurological symptoms including weakness, dementia, and paralysis
Stages of HIV Infection

- **Early immune failure**
  - As T cells continue to decline, body becomes increasingly vulnerable to infections
    - Thrush
    - Shingles

- **AIDS: Final stage**
  - The time from HIV infection to AIDS can be 10 or more years
Stages of HIV Infection

- A diagnosis of AIDS is made when an HIV-positive person develops one of the following conditions:
  - Helper T cell count below 200/mm$^3$ of blood
  - One of 26 common opportunistic infections (e.g., Kaposi’s sarcoma)
  - Loss of more than 10% of body weight
  - Dementia
Stages of HIV Infection

Effects of HIV on Immune System

Infection with the HIV virus does not immediately cause an individual to develop AIDS but rather causes a slow and steady decline of the individual’s immune system. Symptoms of the disease may not appear until several years after initial infection. This tutorial traces the progression of HIV infection and describes how the virus ultimately cripples the immune system.

Press "PLAY" to begin Animation.
Treatments

- Treat or prevent opportunistic infections
  - Can improve quality of life and lengthen life of AIDS patients
- Slow the rate at which HIV can make new copies of itself
  - Several classes of antiviral drugs
  - Each blocks a particular step in the replication process of HIV
Treatments

- Antiviral drugs preventing HIV from entering a cell

- Efforts at vaccine development are challenged by the characteristics of HIV
  - High mutation rate
  - Two types of HIV and many strains
  - Antibodies cannot attack the virus when it is hidden in a host cell
  - HIV can pass directly from the interior of an infected cell to the interior of an adjacent uninfected cell
  - Antibodies can attack viruses outside the cell only; they cannot prevent the virus from spreading by this means of transmission
Treatments

Differing Views of the Relationship between HIV and AIDS
You Should Now Be Able To:

- Understand the long-lasting effects of STDs
- Know the STDs caused by bacteria:
  - Chlamydia
  - Gonorrhea
  - Syphilis
You Should Now Be Able To:

- Know the STDs caused by viruses:
  - Genital herpes
  - HPV and genital warts

- Know what is HIV and what is AIDS
  - Structure and replication of HIV
  - Mode of infection and phases of infections
  - Treatments